of late attained to so important a position. In the Whitehead, or fish-torpedo, the electric fluid, it is true, plays no part, but this is the only notable exception. In the floating torpedo, the moored torpedo, and the spar-torpedo, electricity is the life and soul; at one moment the machine is but a floating buoy or sunken impediment, the next it is transformed into a terrible volcano. A feeble current of electricity flashing along the wire, has on the instant sufficed to bring about the fatal change.

Passing from torpedo warfare and the recent attempts that have been made to turn electricity to account in the construction of self-steering launches, we come to a scarcely less important matter, that of firing guns by the electric spark. Not only are guns at proof and those under experiment so ignited, but on board the modern ironclad it is the custom now-a-days to fire broadsides in this wise also. By leading wires from every gun to one point, which is specially adapted for observation, the double advantage is secured of bringing about the firing at the most opportune moment, and of securing a simultaneous discharge. Some experiments made in Germany have proved beyond doubt that an armour plate struck instantaneously in this way by several shot, may be effectively broken up, whereas the ordinary broadside fire, brought about by gunners at word of command is incapable of doing so. The wires may be led into an observing tower, or half way up the mainmast if need be, and here the firing officer can calmly consort his measures undisturbed by the smoke, and noise, and bustle going on below him. He is provided with proper sights, and the guns being laid in accordance with his orders, he can watch the opportunity for firing as well as if he had his eye to the weapons themselves.

Finally, we have the use of the electric light in warfare. It is the most recent application of all of this wonderful agent, and we should hesitate to say how extensive may hereafter be the employment of electricity in this connection. In the Franco-German war, the first use of this powerful source of illumination was made by the French engineers, and from the forts around Paris the electric rays were made to sweep in all directions, to watch for hostile troops engaged in the operation of mining. Bodies of soldiers upwards of a mile distant could be plainly seen by the vivid light of the electric lamp, and working parties were frequently compelled to abandon their object in the presence of this powerful detector. As a means of discovering the approach of torpedo launches at night, the electric light will obviously be of value, and already a trial of it has been made in several of Her Majesty's ships. The *Alexandra*, the flagship of the Mediterranean fleet, is provided with an electric lamp, worked by one of Wilde's powerful machines, so that the efficiency of the apparatus may be practically tested. Experiments, however, have already shown what the electric rays are capable of doing, and a low torpedo-launch cannot approach within a thousand yards without detection, while if painted of a neutral grey, so as the better to escape observation by day, the vessel, it appears, is all the more perceptible under electric illumination. Steamers, we are told, are peculiarly liable to be detected by an electric lamp, since the rays are reflected by the steam and smoke as effectively as if the latter were a solid screen. How valuable, too, the electric light on board ship must prove for signalling purposes may be gathered from the fact that the Dungeness light, which was the first one of an electric nature constructed in this country, can be seen on a clear night at a distance of thirty miles with all the brilliancy of a star of the first magnitude.

H. BADEN PRITCHARD

THE GEOLOGY OF THE VIENNA WATER SUPPLY

Geologie der Kaiser Franz-Josefs Hochquellen-Wasserleitung. Eine Studie in den Tertiär-Bildungen am Westrande des Alpinen Theiles der Niederung von Wien. By Felix Karrer. (K.K. geolog. Reichsanstalt. Vienna, 1877.)

THE publications of the Austrian Geological Institute are deservedly noted for their number, their fulness, and the beauty of their illustrations. Especially are the large quarto memoirs published under the name of *Abhandlungen* remarkable in the latter respects. Consisting usually of complete monographs, sometimes purely palæontological, but more often blending stratigraphy with palæontology in a manner which is too seldom resorted to in this country, these handsome volumes are quite independent of, whilst they frequently illustrate, the maps issued by the same authority.

The present work forms vol. ix. of this important series. In many ways it is unlike its forerunners, but it resembles them in its completeness and in the finished character of its plates. Although eminently local in interest yet so many points are touched upon—or rather fully discussed—in Dr. Karrer's memoir that it appeals to the civil engineer, the hydrologist, the archæologist, and the chemist in almost as great a degree as to the geologist and the systematic palæontologist.

This great closely-printed book of more than four hundred pages, with its numerous tables and large folding plates, is strictly what its title implies, viz., an account of the geology exposed by the engineering works recently carried out in order to bring the waters of the Kaiserbrunnen and Stixtenstein springs to Vienna, a distance of some twelve Austrian or fifty-five English miles.

All the leading features of this section could probably have been described and commented on with apparent fulness in a short paper in the *Verhandlungen* of the Institute, but the aim of the author has been to raise the character of his memoir from that of a passing pamphlet to that of a thoroughly exhaustive record of all the facts—the seemingly unimportant as well as the obviously valuable—which could be brought within the natural limits of his subject. In this object he has perfectly succeeded, and the result is an orderly collection of minute stratigraphical and other details such as, we believe, have never before been brought together with reference to so small an area.

From Kaiserbrunnen at the foot of the Schneeberg and from Stixtenstein a little further north to the very streets of the Capital, or, geologically speaking, from the triassic heights of the Noric Alps to the drift and alluvium overlying the Tertiary beds of this Alpine portion of the Vienna Basin, only those valleys across which the aqueduct replaced the cutting and the tunnel were left unsearched and unplotted by Dr. Karrer. Every bed, band, thinning,

thickening, fault, slip, or flexure cut through by the artificial channel was measured and noted by him, and all these details are laid down on a true scale (except in one unavoidable instance) in twelve carefully drawn and coloured plates of sections. So far, however laborious, the work done may be said to be more or less mechanical. This is not the case with regard to the clear sketch-sections or outline views which accompany the measured lines. In these we have exhibited to us the relations in which the rocks seen in the cuttings stand to those of the surrounding country, and we perceive at once the eye and hand of the field-geologist.

Since 1859 Dr. Felix Karrer's name has been constantly before the scientific world as that of an active member of Ritter von Hauer's brilliant geological staff. His researches have lain principally among the beds of the Vienna Basin and their fauna. In conjunction with Theodor Fuchs his papers on these and allied subjects have been both numerous and valuable; but more particularly has Dr. Karrer devoted himself to the study of the Foraminifera which these deposits yield in such abundance, and now it may be said that he fitly succeeds to the honourable place so long held by the late Dr. A. E. von Reuss as one of the leading Rhizopodists in Central Europe. Accordingly we find in the present work elaborate tabular lists of the Foraminifera found in the borings and elsewhere in the course of the engineering operations, and no less than seventy-one forms figured and described as new. With reference to these it will be sufficient to observe that many of them are such as, according to the views prevalent in England, would be scarcely held to warrant specific distinction.

The Alpine Vienna Basin, the margin of which between Gloggnitz and Vienna is the region where the geology has been specially worked out, was, it seems, dry land at the time when the Older Mediterranean Sea covered the Basin beyond the Alps. Consequently the Younger Mediterranean Series, its marine sands and gravels passing into grits and conglomerates with intercalated bands of Nullipore limestone and marls, are the lowest of the Tertiary deposits present here. To this series belongs the famous "Leythakalk," about which so much has been written. The fauna of these beds is closely allied to that of the Adriatic of the present day, whilst some of its species denote a somewhat warmer sea. Upon these newer Mediterranean strata rest the Sarmatian beds, in three divisions, the fossils of which allow us to infer a great cooling of the sea accompanied by an invasion of Asiatic cold-sea forms. This was followed by a period of brackish and then of fresh water, which brings us to the well-known Congeria beds, above which only two more members of the Tertiaries occur, viz.: the Belvedere beds and the purely local but highly-interesting freshwater limestone of Eichkogel, near Mödling, which formed the subject of Dr. Karrer's first contribution to science.

It will be readily understood that the works entailed by the construction of the watercourse promised unequalled opportunities for studying in detail the shore facies of these various deposits, and comparing them with the aspects they exhibit in other parts of the basin. That these opportunities have not been lost this memoir affords abundant proof.

From Stixtenstein and Kaiserbrunnen to Ternitz, where the two head-channels meet to form a single watercourse, the rocks cut through are of much greater age. Here we have carefully described by Dr. Karrer, although he does not profess to do so as minutely as his more congenial tertiaries, micaschist and *grauwacke* of uncertain age, and, in disturbed order, the Wetterstein, Guttenstein, and Werfen divisions of the Alpine trias. At Baden and again at Mödling, short spurs running like headlands into the ancient Viennese sea, once more bring the uppermost of these formations (the Wettersteinkalk) within the line of section.

At the former of the two last-mentioned places is a group of well-known thermal springs ranging from ordinary temperatures to 95° F. Several pages of considerable interest are taken up by the discussion by Prof. Eduard Suess of a large series of observations relative to these springs carried on by Prof. Jellinek. Their topographical distribution is peculiar and is strikingly shown on a map (Plate xiii.) by means of isothermal lines, the intervals being of 1° Réaumur from 8° to 13°, then one of 3° from 13° to 16°, and lastly, one from 16° to 28°: that is to say, the spaces between the lines of the first series represent 1° each, then 3°, and lastly 12° Réaumur. This mode of dealing with thermal phenomena by means of contour-lines is new to us and seems fruitful of good results. In the present instance five distinct foci of greatest heat are well made out, with several outlying ones attaining lesser degrees of temperature.

The chemical composition not only of the hot springs, but also of the various waters referred to throughout the book, is given in numerous analyses by chemists of note.

The line of the watercourse runs more or less parallel to the Southern Railway. In 1840, when the latter was in course of construction, several discoveries of prehistoric implements were made at Potschach, and elsewhere. It is therefore not surprising that the new excavations should have given rise to similar finds. Of these the most important appears to be an old burial-ground of the bronze age at Leobersdorf, a little to the south of Baden. Here bronze rings, daggers, armlets, &c., were found associated with fairly-preserved human remains. The former are described by Baron von Sacken, the Director of the Imperial Collection of Antiquities, whilst full details respecting the latter are furnished in an anthropological chapter by Friedrich Steller. Both are well illustrated by coloured plates and woodcuts.

The question may perhaps be reasonably asked, why so much labour and money have been expended on the particular subject chosen. But when we remember the losses that British geology has sustained by the neglect of so many invaluable sections temporarily exposed in the early canal and railway days and now covered up and lost for ever, we may well regret that no devoted geologist was there to preserve the minute records of the rocks and their disturbances in as accurate and painstaking a manner as Dr. Karrer has done in the case of the Austrian Watercourse. Given the opportunity of issuing a report on so complete a scale—an opportunity which we fear will never occur in England—no objection can be made to his mode of setting forth his results. A more condensed account would have been more readable, and probably more acceptable to foreign geologists, but

among the local investigators in the district to the south of Vienna, which the author delights in calling that "*stückchen Erdrinde*," the book must at once take rank as a storehouse of actual facts never to be over appreciated.

The value of the memoir is much enhanced by the long bibliographical list with which Dr. Karrer opens the work, and which is brought up to date in the appendix. This list contains the titles of 566 books and papers relating to the region traversed by the *Aqueduct*, and arranged, as all such lists should be, in chronological order. The first paper cited is one by Wolfgang Anemarinus, on the Baden springs, and dates as far back as 1511.

From what we have said it will be seen that no labour has been spared to render this report as perfect as it could be made. One serious omission, however, must be called attention to. There is no index. The late Sir Roderick Murchison was wont to deplore that many of the details contained in his "big books" remained unknown and buried within them. But books like the "Silurian System" are certain to be consulted, index or no index. To publish a work so local in character, albeit so complete in its execution as the one under review, as Dr. Karrer has done, without a key to the endless facts it contains, is deliberately to court non-recognition.

Before concluding we would note the excellent geological map of Vienna and its immediate neighbourhood, by Th. Fuchs. This map was first issued in 1874, and is conveniently reproduced in the present memoir.

G. A. LEBOUR

A CENTURY OF DISCOVERY

The Discoveries of Prince Henry the Navigator, and their Results; being the Narrative of the Discovery by Sea, within One Century, of more than Half the World. By Richard Henry Major, F.S.A. Portraits, Maps, &c. (London: Sampson Low and Co., 1877.)

Geschichte des Zeitalters der Entdeckungen. Von Oscar Peschel. Zweite Auflage. (Stuttgart: J. G. Cotta, 1877.)

THESE two works practically refer to the same period, which nearly coincides with the fifteenth century, and deal mainly with the same events. Mr. Major's work centres round Prince Henry as the initiator of the remarkable series of discoveries which were made during the century referred to, while that of the late Oscar Peschel deals with these events as forming a remarkable era in geographical discovery, and is considerably more detailed than the work of Mr. Major. Both works are virtually second editions. In its present form Mr. Major's is somewhat more popular than when first published, the discussion of certain points interesting only to the student having been omitted; Peschel's work, first published about twenty years ago, is practically unaltered. Both works are valuable contributions to the history of one of the most eventful centuries of our era; Mr. Major's is a worthy record of the life and work of a noble-minded prince, while Peschel's is a standard authority on the geographical work of the fifteenth century.

Prince Henry, aptly styled "the Navigator," was the fifth child of King João I., of Portugal, and his Queen Philippa, daughter of "old John of Gaunt, time-honoured Lancaster," and was born in 1394. He was carefully trained by his English mother, and after having distinguished himself at Ceuta, took up his abode on the promontory of Sagres in Algarve, of which kingdom he was made governor in perpetuity. It was from here that during the rest of his life he initiated and directed those discoveries with which his name will be ever associated; to Prince Henry, there is no doubt, the rapid progress of geographical exploration during the fifteenth and sixteenth centuries is mainly due. But not only in this way did he encourage the advance of knowledge; by providing professorships, and in other ways, he did much to foster the progress of science such as it was in his time; his own favourite subjects of study were astronomy and mathematics.

It is with Africa that Prince Henry's name is chiefly associated. Before commencing his great work of exploration he took every means in his power of ascertaining all that was known about Africa, though that was not much. Cape Blanco he knew, though vaguely, but all the coast south of that was practically a blank. The interior was known much farther southwards, and not a few details of Timbuctoo had reached Europe by the beginning of the fourteenth century. It does not seem to be known whether Prince Henry had the means of making himself acquainted with the work done by the Phœnicians and Carthaginians; the narrative of Hanno's famous coasting voyage would have been a treasure to him, but the likelihood is that he was totally ignorant of the work accomplished by these pre-Christian explorers. Nor is it likely that he had heard of the Norse discovery of America, though he may have heard of the famous voyages of the brothers Zeni; if he had it does not seem to have suggested to him the existence of a great continent far beyond the horizon which bounded his outlook from Sagres. Prince Henry set about the work of African exploration with intelligence, his clear object apparently having been to trace the African coast to its southernmost limit, and even discover by rounding it a practical sea-route to India.

"Very few details are left us," Mr. Major writes, "of the astronomical instruments used in the time of Prince Henry. The altitude of a star was taken by the astrolabe and the quadrant by means of an alidade, or ruled index, having two holes pierced in its extremities, through which the ray passed. The quadrant hung vertically from a ring which was held in the hand. We do not know how these instruments were graduated, but it is to be presumed very roughly. The astrolabe, the compass, timepieces, and charts, were employed by sailors in the Mediterranean at the beginning of the fifteenth century. It is quite certain that the needle was used at sea before Prince Henry's time, for he himself speaks of it when urging on one of his navigators to the rounding of Cape Bojader." During the lifetime of Prince Henry the African voyagers stuck closely to the coast, except when by accident they were driven from it.

The Prince's enthusiasm and generosity drew to him most of the adventurous spirits of his time, and thus it was that after his settlement on Sagres scarcely a year passed that he did not send out one or more expeditions to carry on the great work which he had set himself to accomplish. The first fruit of Prince Henry's enterprise